Case Report

A Case of Exhaustion of Implantable Cardioverter Defibrillator Therapies Due To Inappropriate Programming

Nikolaos K. Fragakis[1], Antonios P. Antoniadis[2], Paraschos Geleris[1]

[1]Third University Cardiology Department, Hippokration Hospital, [2]Second Cardiology Department, General Hospital G. Papanikolaou, Thessaloniki, Greece

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Strategically chosen tachycardia detection and therapy options targeting non-sustained ventricular tachycardia (VT) or ventricular fibrillation (VF) can efficiently reduce the morbidity related to implantable cardioverter defibrillator (ICD) therapy. We report a case of a 60-year-old woman with ischemic cardiomyopathy who underwent ICD implantation due to frequent episodes of non-sustained VT. In this case, the inappropriate setting for VF detection in addition to the limited flexibility in device programming for tachycardia confirmation led to the rapid exhaustion of all available shock therapies.

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Address: Nikolaos Fragakis

42 Kromnis St. 551 31 Thessaloniki, Greece
e-mail: fragakis.nikos@gmail.com

Detection of self-terminating ventricular arrhythmias by implantable cardioverter defibrillators (ICDs) causes unnecessary battery depletion and unneeded shocks. Despite enhanced detection algorithms, the incidence of inappropriate ICD therapy has not been significantly reduced, principally because of physicians' reluctance to program the device adequately.[1,2] This case report describes a sequence of committed shocks in a patient who had runs of non-sustained ventricular tachycardia (VT), finally leading to the rapid exhaustion of shock therapies.

Case presentation

A 60-year-old woman with a history of extended inferior myocardial infarction, moderately impaired left ventricular function and absence of reversible ischemia, received an ICD due to recurrent episodes of non-sustained VT. The ICD device (Lexos DR, Biotronik, Berlin, Germany) was programmed to DDDR mode at a rate of 50 to 120 beats/min. The VT1 detection zone was set at 146 to 176 bpm, the VT2 at 176 to 200 bpm and ventricular fibrillation (VF) at ≥200 bpm. The number of intervals to detect (NID) for VT1 was programmed to 26, with redetection at 20, and the NID for VT2 to 16, with redetection at 14, while the VF detection and redetection were set to 8 of 12. The patient was discharged on amiodarone and beta-blocker.

Six weeks later, she was admitted urgently with repetitive shocks. Device interrogation showed a total of 30 VT or VF episodes during the previous 24 hours, with 16 delivered shocks and 2 occurrences of successful antitachycardia pacing. Interestingly, 7 unsuccessful shocks were recorded during a specific VF episode which lasted 11 minutes and 1 second. During this event, 126 redetected episodes in the VF zone were documented. Evaluation of the stored electrograms (EGM) from this specific episode revealed eight sequential capacitor charges, followed by seven delivered shocks. Thereafter the device was un-

able to provide further therapies, as the maximum of available shocks had been reached.

In reviewing the EGM of this specific episode, VF was initially detected appropriately. However, therapy was aborted, because the device recorded 3 out of 4 ventricular sensing events during the confirmation algorithm (Figure 1a). Shortly after, VF was again sensed, resulting in recharging of the device and delivery of a maximum output shock of 30 joules. The second therapy, however, was delivered as a committed shock, since the first episode was considered as non-terminated. According to the Lexos DR ICD specifications, 12 out of 16 R-R intervals greater than the VT interval parameter of the lowest VT class (>410 ms) must elapse before the episode is considered as terminated.[3] Otherwise, the ICD initiates its own internal counter of events for redetection. In our case, 8 out of 12 intervals were smaller than the VF interval parameter (Figure 1b).

The same phenomenon was repeated for 6 episodes, one after the other, until the maximum of eight consecutive capacitor charges was reached. Subsequently, the device was only able to redetect the ongoing tachycardia without being able to deliver therapy (Figure 2). The episode was finally terminated after 11 minutes and 1 second. Interestingly, the 8th shock was not aborted despite the presence of 3 out of 4 ventricular sensing events, as it was a committed shock (Figure 3).

A possible solution to this problem could be to increase the rate of VF detection and the number of beats required for detection and redetection of VF or VT. An additional option is to increase the rate for VT detection; this will facilitate characterization of VF episodes as terminated, but it might also inhibit therapy for relatively slow sustained VT.

We indeed increased the initial VF zone to 240 bpm, with detection and redetection settings programmed to 12 out of 16 intervals. The NID for VT1 was programmed to 30, with redetection at 28, and for VT2 to 26, with redetection at 20. We also decreased the intervals for VT1 detection to 390 ms and programmed as non-committed the first two shocks, which is the maximum number permitted by the device. This new reprogramming reduced the episodes of shocks dramatically, as the patient had only 1 appropriately delivered shock during the next month.

Discussion

This case report reconfirms that ICD patients frequently have self-terminating device-detected VF. Furthermore, it provides an example of how inappropriate ICD programming in patients with non-sustained VTs could be disastrous. The resulting rapid exhaustion of all provided therapies leaves the patient totally unprotected in the face of non-terminated tachyarrhythmias.

Several studies have shown that inappropriate therapy due to non-sustained VT can be prevented by programming longer VT/VF detection and rede-

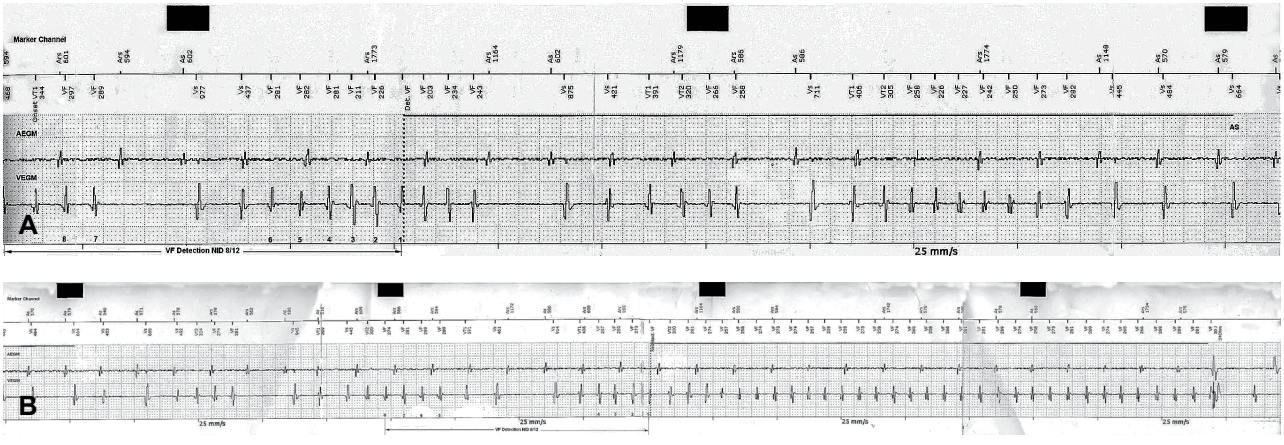

Figure 1. A) Stored electrograms and marker channel of rapid ventricular tachycardia detected in the ventricular fibrillation (VF) zone with number of intervals to detect 8 out of 12. VF terminated spontaneously during capacitor charging (3 out of 4 ventricular sensing events) resulting in an aborted shock. B) Continuation of the same episode. VF is redetected and a committed shock is delivered.

AEGM – atrial electrogram; AS – aborted shock; NID – number of intervals to detect; VEGM – ventricular electrogram; VF – ventricular fibrillation; VS – ventricular sense; VT1 – ventricular tachycardia 1 sense; VT2 – ventricular tachycardia 2 sense.

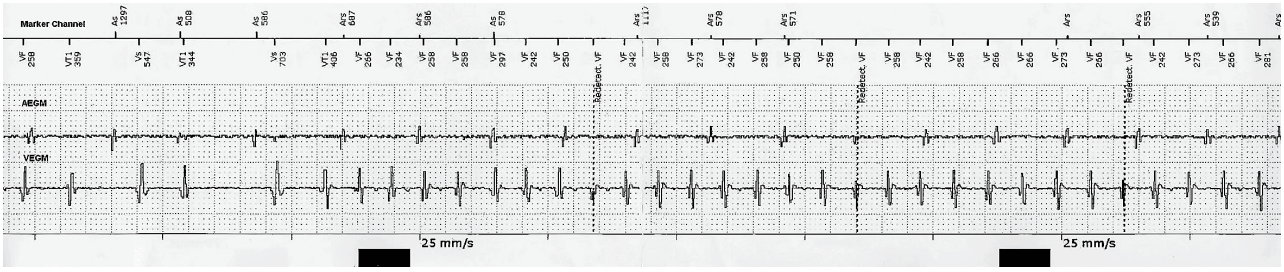

Figure 2. Continuous redetection of the ongoing VF without provision of further therapy due to completion of the available shocks.

Abbreviations as in Figure 1.

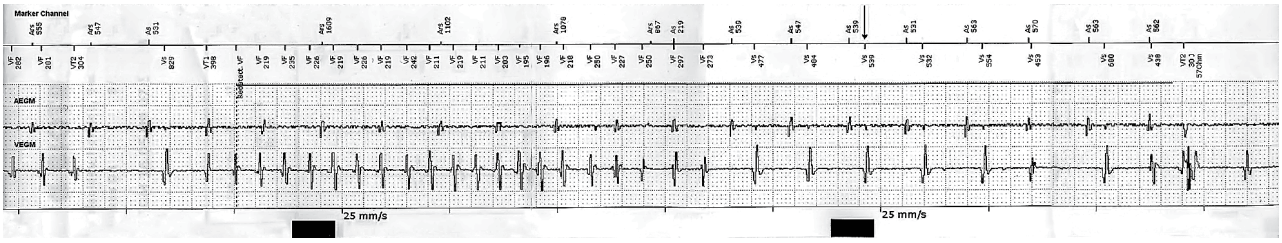

Figure 3. Stored electrograms and marker channel during the 8th consecutive capacitor charging of the same episode. Delivery of a committed shock despite the spontaneous termination of VF (3 out of 4 ventricular sensing events recorded indicated by arrow).

Abbreviations as in Figure 1.

tection criteria. This, in turn, results in fewer unnecessary shocks with minimal delay in VF detection.[1,4-6]

Inappropriate shock delivery or antitachycardia pacing may also arise from the confirmation algorithm.[7] Although the algorithm aims to confirm the persistence of tachycardia during or after the capacitor charging but before shock delivery, many devices do not allow these therapies to be programmed as non-committed during the redetection period. Specifically, in our ICD there is the option of programming only for the first 2 shocks as non-committed. In addition, when one shock is aborted the next shock will be committed, as occurred here.[3] A redesigned confirmation algorithm allowing more options for non-committed therapies would prevent overtreatment of self-terminating tachyarrhythmias.

References

1. Wathen MS, DeGroot PJ, Sweeney MO, et al. Prospective randomized multicenter trial of empirical antitachycardia pacing versus shocks for spontaneous rapid ventricular tachycardia in patients with implantable cardioverter-defibrillators: Pacing Fast Ventricular Tachycardia Reduces Shock Therapies (PainFREE Rx II) trial results. Circulation. 2004; 110: 2591-2596.
2. Tzeis S, Andrikopoulos G, Kolb C, Vardas PE. Tools and strategies for the reduction of inappropriate implantable cardioverter defibrillator shocks. Europace. 2008; 10: 1256-1265.
3. Lexos DR: References manual. Biotronik, GmbH & Co, KG.
4. Gunderson BD, Abeyratne AI, Olson WH, Swerdlow CD. Effect of programmed number of intervals to detect ventricular fibrillation on implantable cardioverter-defibrillator aborted and unnecessary shocks. Pacing Clin Electrophysiol. 2007; 30: 157-165.
5. Wilkoff BL, Ousdigian KT, Sterns LD, Wang ZJ, Wilson RD, Morgan JM. A comparison of empiric to physician-tailored programming of implantable cardioverter-defibrillators: results from the prospective randomized multicenter EMPIRIC trial. J Am Coll Cardiol. 2006; 48: 330-339.
6. Wilkoff BL, Williamson BD, Stern RS, et al. Strategic programming of detection and therapy parameters in implantable cardioverter-defibrillators reduces shocks in primary prevention patients: results from the PREPARE (Primary Prevention Parameters Evaluation) study. J Am Coll Cardiol. 2008; 52: 541-550.
7. Tzeis S, Andrikopoulos G, Rassias I, Theodorakis G. Tachycardia induction due to inappropriate implantable cardioverter defibrillator therapy: what is the mechanism? Hellenic J Cardiol. 2010; 51: 558-562.